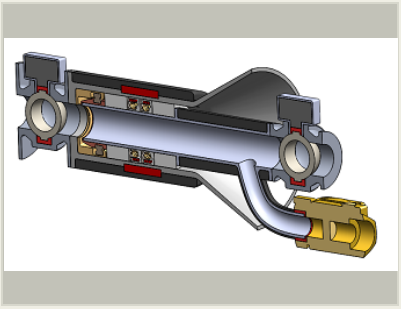
Small Business Innovation Research/Small Business Tech Transfer

Lightweight, High-Flow, Low Connection-Force, In-Space Cryogenic Propellant Coupling, Phase II

Completed Technology Project (2017 - 2019)

Project Introduction

Three of the key abilities needed for making future NASA and commercial launch and in-space transportation systems more affordable and capable are: a) the ability to "live off of the land" via in-situ resource utilization (ISRU), b) the ability to reuse in-space transportation hardware, and c) the ability to leverage continuing advancements in lower-cost earth-to-orbit transportation. All of these abilities require the ability to transfer large quantities of cryogenic liquids (Oxygen, Hydrogen, and Methane) between tanks on separate vehicles. While all cryogenic rocket stages have to have a propellant fill/drain coupling for loading propellant on the ground, existing designs are not capable of in-space refuelability. A dual-purpose coupler that could be used for both ground fill/drain and for in-space refueling would be extremely valuable.In this proposed SBIR Phase II research effort, Altius Space Machines proposes continuing the development of just such a dual-purpose, lightweight, high-flow cryogenic propellant coupling to enable both ground fill/drain and in-space refueling. This coupling incorporates an innovative new cryogenic sealing architecture to enable a coupling with very low insertion/extraction forces, for manual, robotic, and astronaut-connected cryogenic propellant transfer operations. In Phase I, Altius demonstrated the innovative new cryogenic sealing architecture, and performed insertion/extraction and leak tests, demonstrating significant improvements over traditional spring-energized polymer seals, raising the TRL from 2 to 3 at the end of Phase I. In Phase II Altius will continue refinement of the cryogenic sealing architecture, and will design, fabricate, and test a family of couplers based on this architecture, and focused on an industry-provided launch vehicle application. Testing of the ground and in-space couplers during Phase II will raise the system TRL to 6, paving the way for Post-Phase II flight demonstration (yielding TRL 9).



Lightweight, High-Flow, Low Connection-Force, In-Space Cryogenic Propellant Coupling, Phase II Briefing Chart Image

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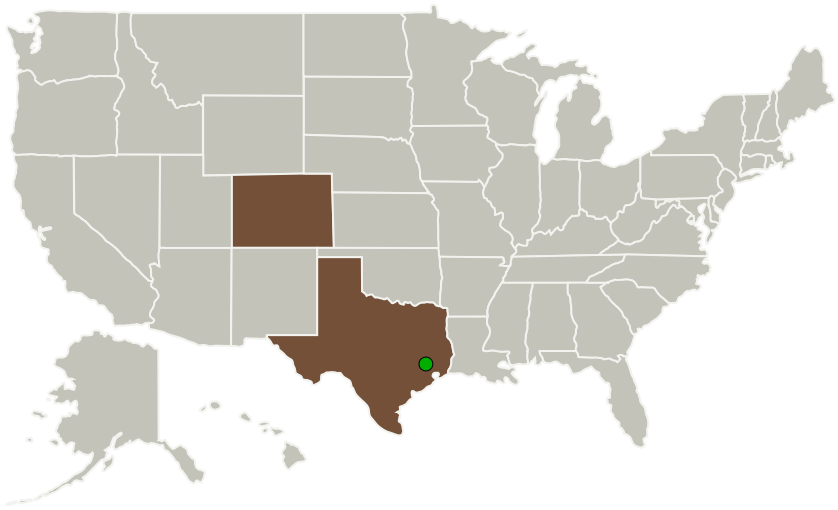
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Altius Space Machines, Inc.	Lead Organization	Industry	Broomfield, Colorado
Johnson Space Center(JSC)	Supporting Organization	NASA Center	Houston, Texas

Primary U.S. Work Locations	
Colorado	Texas

Project Transitions

May 2017: Project Start

April 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141098)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Altius Space Machines, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

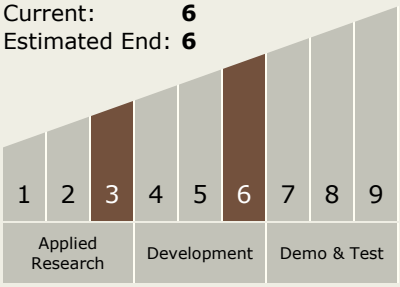
Carlos Torrez

Principal Investigator:

Geoffrey Licciardello

Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



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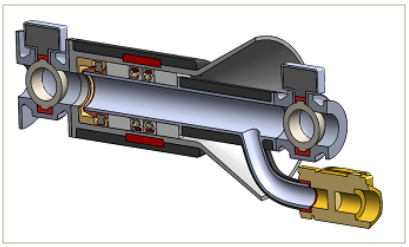
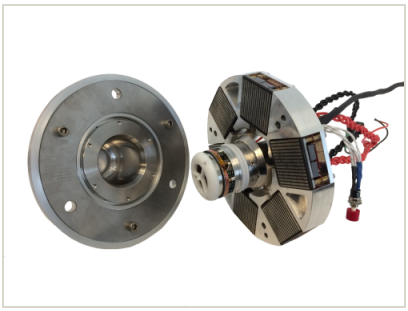
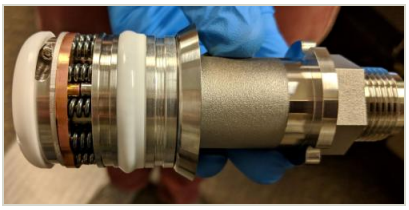
Images



Briefing Chart Image
Lightweight, High-Flow, Low Connection-Force, In-Space Cryogenic Propellant Coupling, Phase II Briefing Chart Image
(https://techport.nasa.gov/image/130735)



Final Summary Chart Image
Lightweight, High-Flow, Low Connection-Force, In-Space Cryogenic Propellant Coupling, Phase II
(https://techport.nasa.gov/image/127997)



Final Summary Chart Image
Lightweight, High-Flow, Low Connection-Force, In-Space Cryogenic Propellant Coupling, Phase II
(https://techport.nasa.gov/image/125867)

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.2 Electric Space Propulsion
    - TX01.2.1 Integrated Systems and Ancillary Technologies

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System